RECONSTRUCTION OF EUROPAN TERRAIN IN THE GALILEO C3 "WEDGES" IMAGE AND ITS GEOLOGICAL IMPLICATIONS: B. R. Tufts (1), R Greenberg (1), R. Sullivan (2), R. Pappalardo (3) and the Galileo Imaging Team. (1) Lunar and Planetary Lab, University of Arizona, (2) Arizona State University; (3) Brown University

A reconstruction of terrain in the Galileo C3 "Wedges" image of Europa (s0368639400; centered at 17S, 195W) re-assembles older features and closes two prominent NW-SE trending dark wedge-shaped bands [1] and an EW trending intermediate-toned band [2]. Thus, the bands probably are gaps which opened due to relative translation and/or rotation between lithospheric plates and then filled-in with material from below. This is consistent with analyses of nearby wedge-shaped bands seen in Voyager 2 images [3, 4] and with parallel Galileo investigations of crustal disruption on Europa [5-7]. The analysis here makes use of 420m/pixel image resolution which greatly improves upon the 2km/pixel Voyager 2 imagery on which previous geological studies of the region were based [1-4, 8-10]. At this higher resolution, the morphology of reconstructed terrain provides new evidence of geological events that modified Europan plains before the bands opened.

This three-step reconstruction re-assembles: 1) an oblong "island" ("**O**") measuring approximately 65km by 13km, located where the westernmost wedge-shaped band ("**B**") and the intermediate band ("**D**") intersect; 2) an extensive lineament ("**L**") crossing the image from SW to NE; and 3) various smaller lineaments. (See Figures 1 and 2.) To reconstruct the "island" and the long lineament coherently, the wedge-shaped and intermediate bands cutting them had to close by distances equal to their widths. If the material within the bands concealed a down-dropped graben floor, or if the material were lithosphere that had stretched on multiple normal fault blocks (such as proposed for "tectonic resurfacing" [11] of the Uruk Sulcus region of Ganymede [12, 13]), then space problems would prevent full closure. Also, if disrupted linear features intersect the bands at acute angles, extensional resurfacing would move surviving piercing points towards the acute angle and away from positions opposite one another. The puzzle-like closure of the bands and the constraints of multiple feature match-ups indicate that such relocation has not occurred.

Fill material may be analogous to terrestrial sheeted dikes. Sullivan [5] has prepared a multi-plate reconstruction of wedge-shaped band **B** plus narrower dark bands in this image and interprets ridge patterns within the bands to indicate episodic [4] crustal spreading [5].

These conclusions are consistent with inferences about lithospheric separation elsewhere on Europa [3, 4, 14-16]. As in those cases, the lateral motion of reconstructed plates implies presence of a subsurface decoupling layer [5]. This was proposed first regarding wedge-shaped bands near the C3 Wedges image area [3, 4]. Interplate gaps on Europa may be bounded by near-vertical tension fractures [4, 14, 15, 17] perhaps indicating thickness of the brittle lithosphere. This latter interpretation is not universally accepted [18].

Because they are extensive, the bands make excellent stratigraphic markers. Relatively few ridges seem to have formed between the opening of the intermediate band and the wedge-shaped bands, so formation of all three may have spanned a comparatively brief interval. A measure of the time involved may be the brightening that the intermediate band seems to have undergone [1, 5, 19, 20]. In general, the long curvilinear or sinuous ridges seem to post-date the bands, although some are contemporaneous with them [5]. The complex, interweaving, platform-like ridges usually pre-date the bands. Open issues include the rate of ridge formation and whether the later ridges are genetically similar to the earlier ones.

From superposition, dissection by the prominent bands began with opening of the EW band followed by the NW-SE bands (although it is not yet clear which of these two wedge-shaped bands came first). (See figure.) Dominant stress orientations must have rotated or relative stress magnitudes switched between the two events, resulting in the angle between the lighter and darker bands. The intermediate band may be one of a group of light-toned, EW and NNE trending lineaments [1, 2, 8, 9] visible in the anti-Jove region. Some may have been reactivated by the wedge-shaped bands [10].

The EW band (and possibly the wedge-shaped bands) may be chronologically and structurally [15] analogous to "gray bands", first identified near the Europan south pole [1]. Gray bands have been considered the "oldest recognized deformation" on the satellite [1, 21]. However, features visible at Galileo resolution on the reconstructed "island" provide evidence of earlier tectonism, consistent with new findings in the south polar region [16, 17]. The "island" is surrounded by faint, thin ridges, giving it a discrete identity. It has a relatively smooth "lowland" appearance except for vague internal ridges which align with similar ridges on the neighboring terrain to the NW. It contains one of only two probable impact craters more than 5 pixels wide in the image, a bowl-shaped crater with a sharp rim and a surrounding dark deposit.

Apparently, after the formation of the original "island" terrain, ridges developed on it. Later it became isolated topographically (or even mechanically) from adjacent territory with the creation of the thin, bounding ridges. (This event may correspond to the "disruption" of bright plains proposed by Lucchitta and Soderblom [1].) How are these two ridging episodes related to the platform-shaped ridges to the north? Also, while the location of the crater on the "island" may be a coincidence, its presence there suggests the possibility that this block is a relic of a more heavily cratered landscape.

References cited: [1] Lucchitta and Soderblom (1982) Satellites of Jupiter, 521. [2] Kozak etal. (in review) US Geological Survey. [3] Schenk and Seyfert (1980) EOS Trans, v61: 286. [4] Schenk and McKinnon (1989) Icarus, 83, 75. [5] Sullivan etal, Galileo, this vol. [6] Greeley etal., General, this vol. [7] Belton etal. (1996) Science, v274, 377. [8] Pieri, Nature, 1981. v289, 17. [9] Lucchitta and Soderblom (1981) LPSC 12B, 1555. [10] Tufts (1993) LPSC 24, 1445. [11] Head etal., Tect., this vol. [12] Pappalardo etal., Ganymede, this vol. [13] Pappalardo etal., Origin, this vol. [14] Golombek and Banerdt (1990) Icarus, v83, 441. [15] Pappalardo and Sullivan (1996) Icarus, v123, 557 [16] Tufts (1996), LPSC 27, 1343. [17] Schenk and Pappalardo (1996) Eos, Trans., v78 (33) S173 [18] Leith and McKinnon, (1996) Icarus, v120, 387 [19] Geissler etal, (1996) Eos, Trans, v77 (46), F438. [20] Clark etal (1997) Europan terr., this vol. [21] Geissler etal. (1997) Galileo multispectral, this vol.

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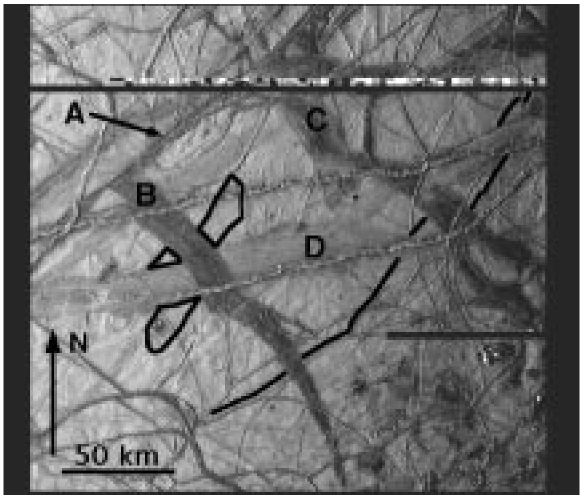


Figure 1a (above)

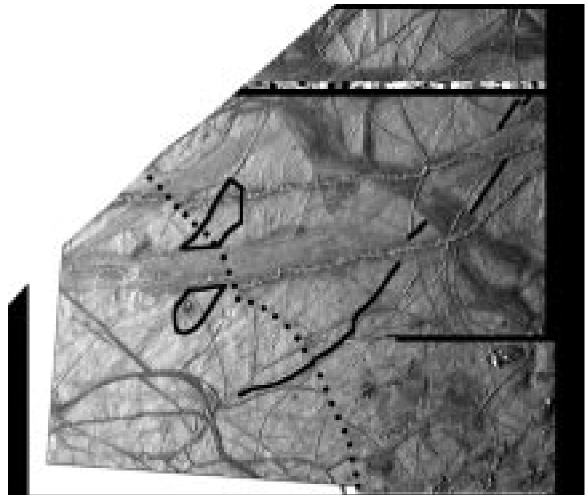
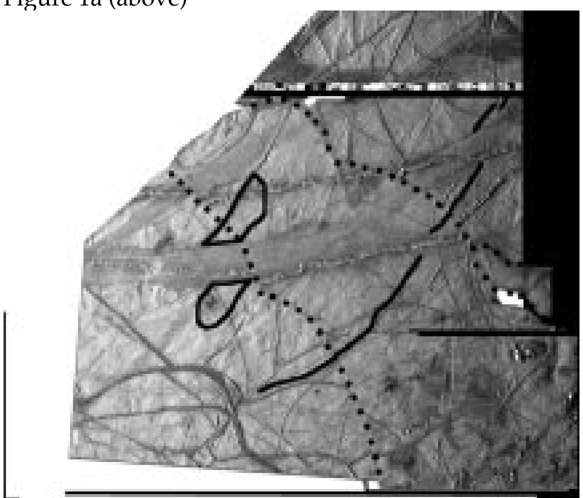


Figure 1b (above)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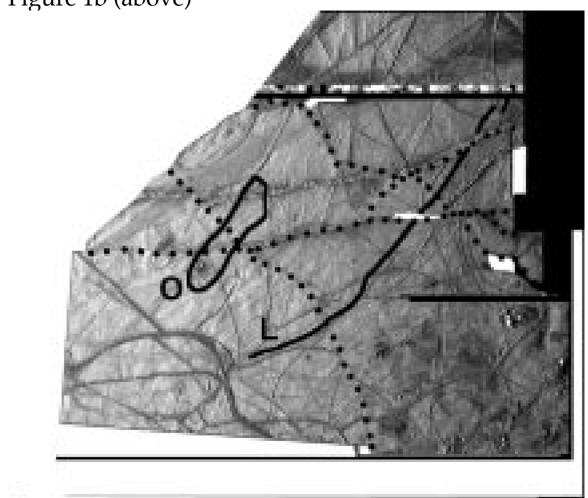

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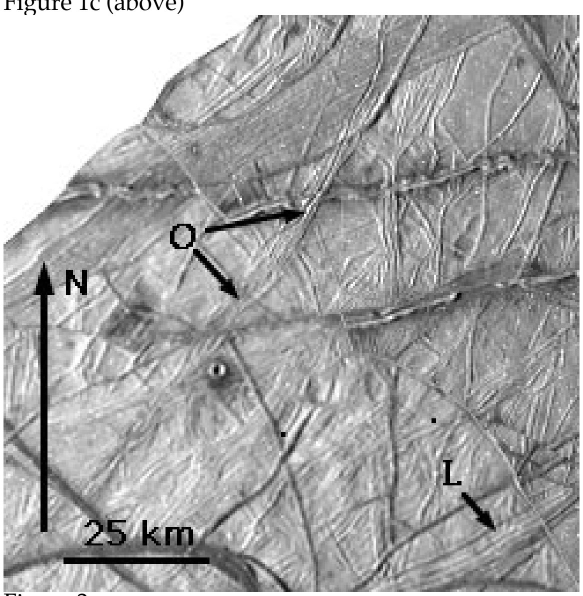

Figure 2

Figure 1a) C3 "Wedges" image (with data gaps). Bands **A**, **B**, **C** are relatively young; **D** is older. We go back in time, closing **B**, **C** and **D**. The order **B**, **C** is arbitrary. Band **A,** a probable strike-slip fault [4], is not reconstructed in this study, so terrain north of **A** is removed in **1b-d** for clarity.

Figure 1b) With digital cuts (main cuts dotted), **B** is closed by rotating and/or translating terrain until a fit is reached matching opposing band boundaries and older landscape features. Minor cuts (not shown) adjust for local deformation and improve fit.

Figure 1c) Similarly, **C** is closed - with digital cuts accounting for the branching of the band.

Figure 1d) Closing band **D** completes the re-assembly of the "island" "**O**" and the lineament "**L**". Bands have closed by their full widths. Younger lineaments have been disrupted. Slight gores remain.

Figure 2) Magnified view of "island" "**O**", as re-assembled. Its internal and bounding ridges are evidence of geologic events predating the opening of the bands. While the location of the crater on the "island" may be a coincidence, its presence there suggests the possibility that this block is a relic of a more heavily cratered terrain.